# The Doctrine of ECLIPSES, with a particular Account of the Great ECLIPSE

April. 1724.

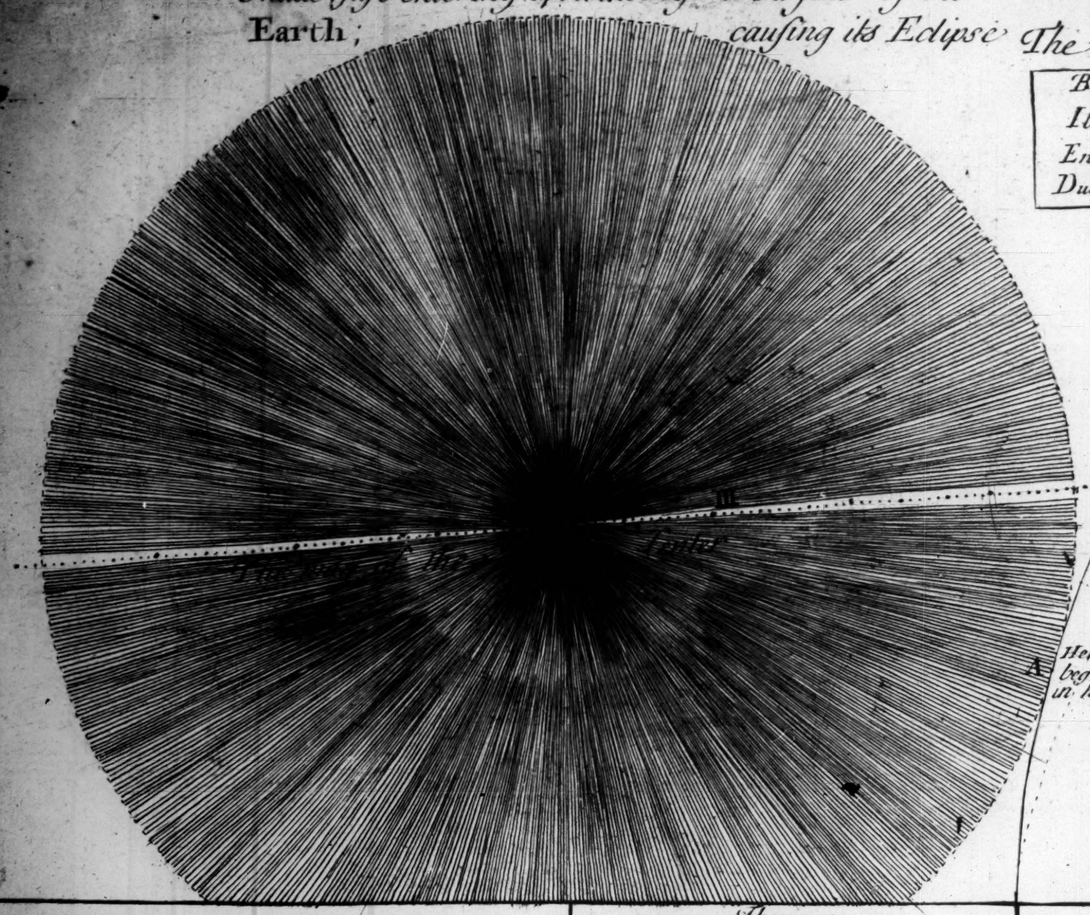
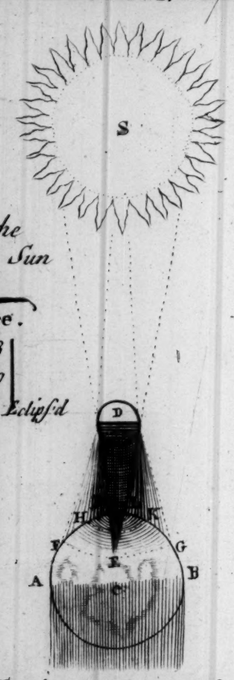



Fig.: 2d.



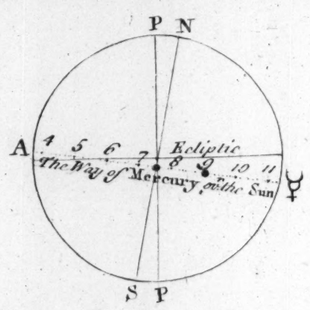

The Time of the Eclipse of the Sun at

| | London. | Venice. |
|---|---|---|
| Begins | 5h. 39 | 6h. 38 |
| Middle | 6. 35 | 7. 30 |
| End | 7. 27 | Setts Eclipsd |

S. The Sun. ACB. the enlightned half of the Earth. DE the Axis or length of the Shadow. MIN the Circle of total darkness to the inhabitants within the bounds of it. HIK. The Circle the inhabitants of which see the Sun's Eclipsed at the same time. FEG the Circle of the Penumbra or partial Shade involving the Space of 12 Mill.s of Square Miles; to the inhabitants of which, part of the Sun is Eclipsed more or less, as they lie nearer to or farther from the Shadow of total Darkness. Without the Circle FEG towards ACB the Inhabitants see the Sun free from any Eclipse.

N.B. The Shadow is really terminated at the Surface, & its continuation to E is only to represent to the Eye, its length or distance to which the Shadow would otherwise reach.

The Transit of Mercury in April 1753




The times of the Transits of Mercury for this Century visible in London in whole or part

| | | D | H | ′ | | Distant ☉ ″ | |
|---|---|---|---|---|---|---|---|
| p. 1753. | April | 25 | 7 | 20 | M. | 1. 19. | S |
| p. 1786. | | 23 | 6 | 57 | M. | 12. 43. | N |
| p. 1799. | | 26 | 2. | 34 | A. | 4. 12. | S |
| 1736. | October | 31 | 10 | 53 | M. | 13. 5. | N |
| 1743. | | 25. | 11. | 2. | M. | 8. 42. | S |
| 1789. | | 25. | 3. | 53 | A. | 7. 20. | S |
| 1782. | November | 1. | 3. | 44 | A. | 15. 27. | N |

SN The Perpendicular to the way of ☿ passing thro the Center of the Sun upon which the Distance from the Center of the Sun is to be sett of according to the direction of the Table North or South.

A and M. stand for Afternoon and Morning.

The Places over which the Center of Darkness traverses during t

The Times when the Center of the Shadow is at the Places mark.d

| | | | | | |
|---|---|---|---|---|---|
| B. | IV 00 | H | V 00 | N. | VI 00 |
| C. | 06 | I | 16 | O. | 35 |
| D. | 12 | K | 27 | P. | 37 |
| E. | 24 | L | 36 | Q. | 33 |
| F. | 36 | M | 54 | R. | 40 |
| G. | 48 | | | | |

This Chart of the World is design'd to represent in some measure upon the Surface of the Earth being a very compound Curve time; But to ours, not till 45 min. Afternoon And the Cen two Minutes after 3 at A Proceeds North-Eastward at the it passes over Ter. de Labrador or N. Britain towards Cape Far enters France near St. Malo, passes over Paris, Geneva, & borders of Switzerland, Alps, by Palanza & Bresoia, ends at Mantua, where

the Line of the Center of total Darkness, upon a Mercators Proje and properly not in a Plane. The Sun rises Eclips'd at (A) abo tral Shadow enters upon the Earth about 6 in the Morni rate of 2000 Miles an hour over California, Mississippa River well, then changing its direction to South-West passes the N

# A compendious VIEW of the NATURE and KIND of ECLIPSES, particularly that of the SUN and EARTH, that will happen the 11th of May in the Afternoon, 1724.

*An Eclipse.* AN Eclipse is the Loss of Light really, or in Appearance, in any of the

permanent Spots on *Jupiter*; for they always appear in that Place upon *Jupiter*, where some Satellite seen from the Sun would appear. They also move from the Eastern to the Western Limb of *Jupiter*, with a Motion equal to that of the Satellites to which they belong, the Satellites themselves soon after following them. If they happen before the Opposition of *Jupiter* to the Sun, or having already passed before, if *Jupiter* has been in Opposition to the Sun, sometimes several Spots has been seen at once, moving after this Manner, having the Satellites to which they belong, preceeding or following them.

*Of the Moon.* The Eclipses of the Moon is caused by her passing thro' the Shadow projected by the Earth, at a full Moon, as an Eclipse of the Earth is produced by the Moon's Shadow falling upon some Part of the enlighten'd Hemisphere of the Earth, I shall only observe, that Lunar and Solar, or more properly, Terrestrial Eclipses, revolve periodically; and that the Length of this Period is about 18 Years, 11 Days, seven Hours,

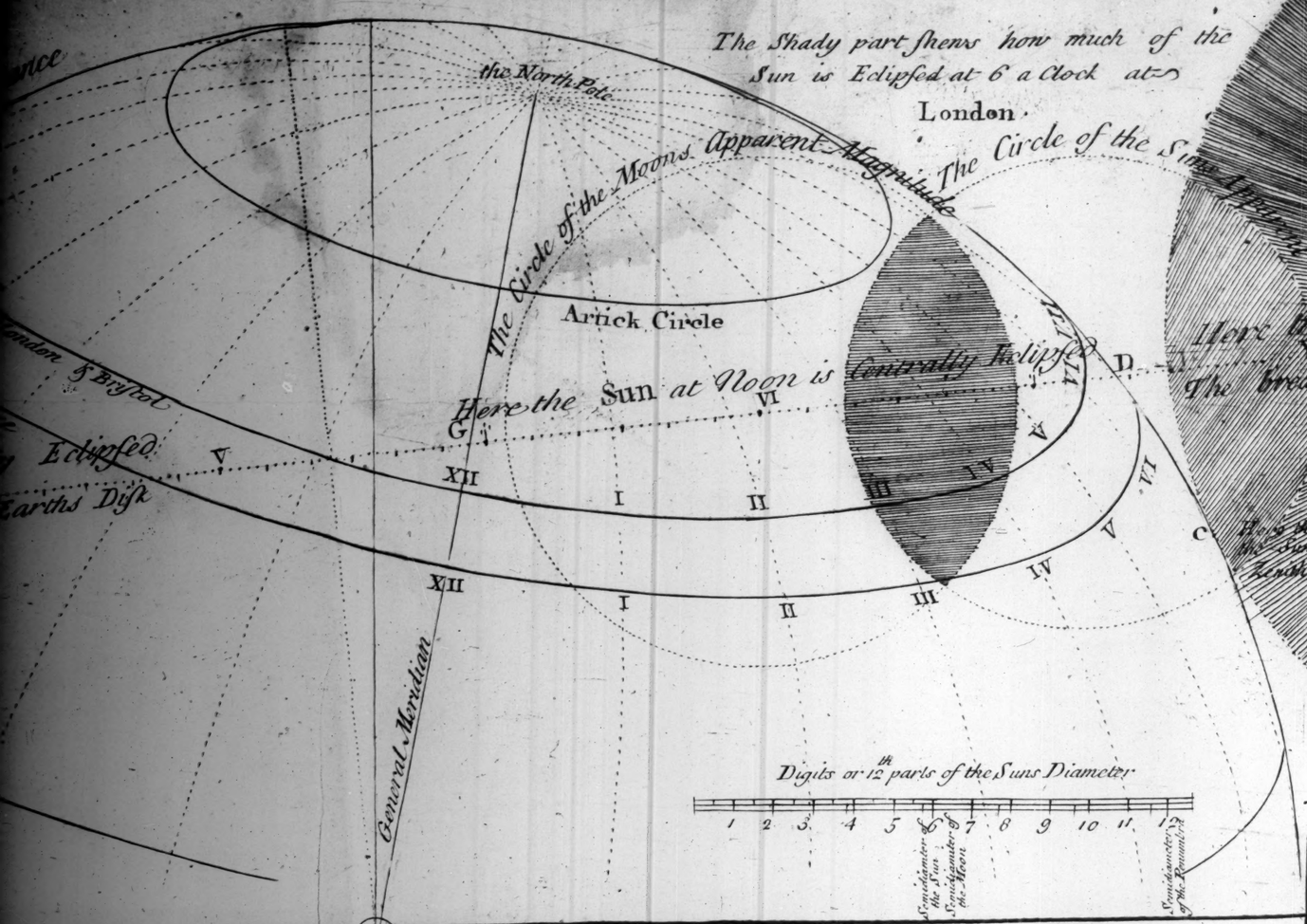
*Penumbra.* Besides the Shade of the M falls, there is what the Astro casioned but by Part of the S it falls.

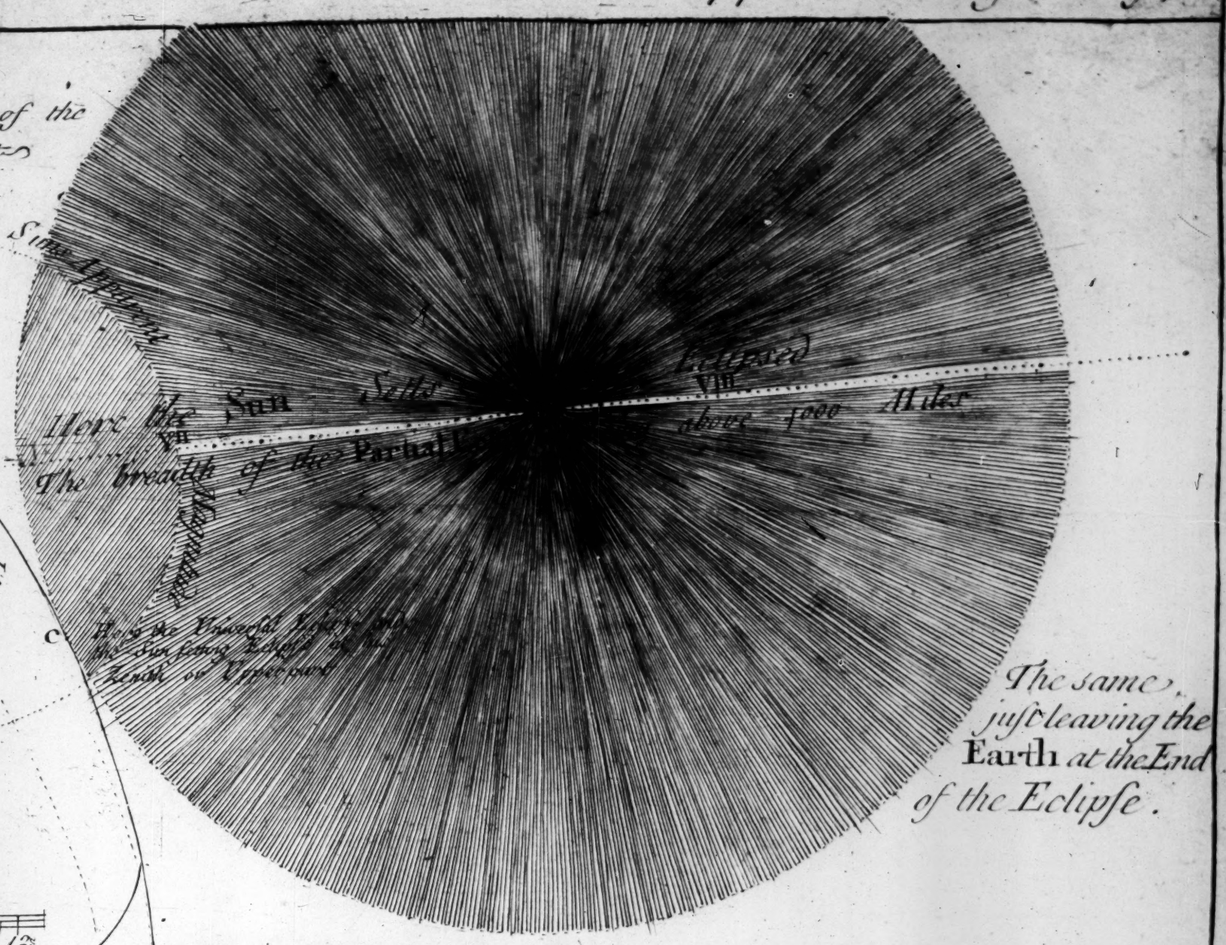
This partial Eclipse is great Darkness, (M. N. L.) and less t which, the Sun appears with total at (M. N. L.) just half at

*The general Scheme of the Eclipse of the* One half of the Earth's Sur served, the Circle bounding the Plain of this Circle is called the ern half, as seen at the Distanc

April 1724.

# ...t of the Great ECLIPSE of the SUN & EARTH which will happen the 11th of May 1724

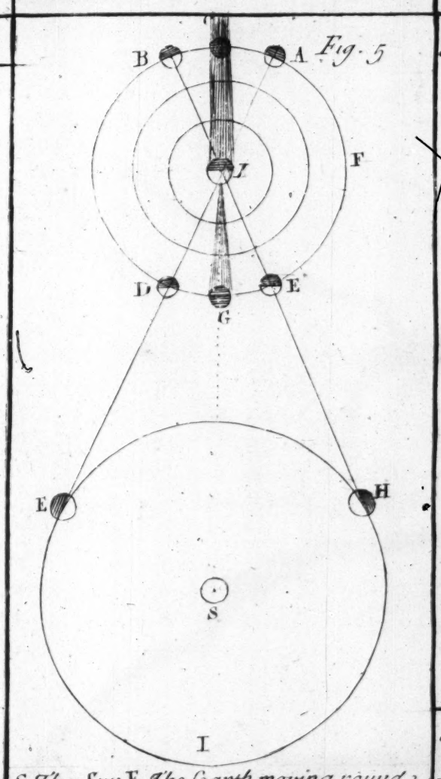



...which the Center of Darkness traverses during the General Eclipse

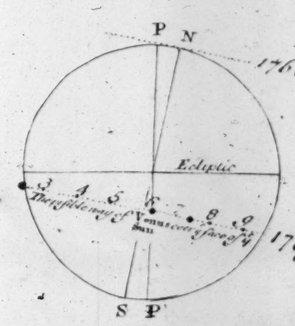
...the Line of the Center of total Darkness, upon a Mercators Projection ... of the Earth the Line it really describes ... and properly not in a Plane. The Sun rises Eclipsed at (A) about 6. 35. in the Morning, according to their ... -tral Shadow enters upon the Earth about 6 in the Morning according to their time and to ours forty ... rate of 2000 Miles an hour over California, Mississippi River, Hudsons Bay; whence moving Eastward ... well, then changing its direction to South West it passes the Northern Ocean, crosses Ireland and England ... over the borders of Switzerland & Alps, by Palanza & Brescia, ends at Mantua, where the Sun sets Centrally Eclipsed about 40. after 6.

## The Eclipses of Jupiter and his four Satellites




S. The Sun E. The Earth moving round the Sun from E. to I. & H. I Jupiter with his 4 Satellites or little Moons. A Satellite moving from E. towards F. will suffer an occultation by the body of Jupiter; at A, tho not eclipsed, arriving at C will be eclipsed; at D there will be a transit of the Satellite over the Disk of Jupiter; in the form of a bright spot. At G an eclipse of Jupiter or dark spot passing over the face of Jupiter after the body of the Satellite, when the Earth is in E, but before the Earth is in H.

## The Transit of Venus May 26. in the Morning 1769




The Times of the Transits of ♀ for the Ancient Ages, and her distances from the center of the Sun in the middle of the eclipse. from Dr. Halley Astron. Regal.

| | d | h | ′ | | Distance a Centr. ⊙ |
|---|---|---|---|---|---|
| May | | | | | |
| 1761 | 26 | 5 | 55 | Morn. | 4. 15. South |
| 1769 | 23 | 11 | 00 | Astern. | 15. 43. North |
| 1990 | 23 | 2 | 13 | A. | 13. 36. S. |
| 2004 | 26 | 7 | 18 | M. | 0. 22. N. |
| November | | | | | |
| 1874 | 27 | 4 | 46 | A. | 3. 3. N |
| 2109 | 29 | 2 | 56 | A. | 14. 38. N |
| 2117 | 27 | 4 | 3 | M. | 10. 5. S |

## The Appearance of the Eclipse at London when Greatest with the Cusps and Digits being two

Position of the Number of Eleven and Fifths

N.B. It will be Total at Guilford Epsom and Windsor at about 3 Min: after 6

Parker Sculp.

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*Penumbra.* Besides the Shade of the Moon producing total Darkness in the Places whereon it falls, there is what the Astronomer call the *Penumbra*, or *Partial Shade*, because occasioned but by Part of the Sun hid by the Moon, from the Inhabitants on which it falls.

This partial Eclipse is greater the nearer the Inhabitants are to the Circle of total Darkness, (M. N. L.) and less the nearer they live to the Circle A. C. B. in Space beyond which, the Sun appears without any Eclipse, tho' at the same Time, it is eclipsed total at (M. N. L.) just half at (H. I. K.)

*The general Scheme of the E-*

One half of the Earth's Surface is always enlightned by the Sun, as has been observed, the Circle bounding the Light and Shade, is called the Circle of *Illumination*; the Plain of this Circle is called the *Disk* of the Earth, and Figure I. represents its North-

## PROBLEM II.

*To find the Number of Digits eclipsed at any Time after the Eclipse is begun.*

THE difference between the Interval for that Time, and Semidiameter of the Penumbra, applied to the Semidiameter of the Sun, divided into 12 equal Parts, shews the Number of Digits eclipsed. Or upon the Time given in the Parallel of the Place, make a Circle with the Sun's Semidiameter; another Circle described with the Moon's Semidiameter, upon the the same Time in the Line of the Moon's Way, will intersect the former; and the Part of the Circle of the Sun cut off, represents the Degree or Quantity of the Eclipse; thus at 6 a Clock the Sun will be eclipsed, as in the SCHEME.

S. *The Sun* A C B *the enlightned half of the Earth*, D E *the Axis or length of the Shadow*. M I N *the Circle of total darkness to the inhabitants within the bounds of it* H I K. *The Circle the inhabitants of which see the Sun Eclipsed at the same time*. F E G *the Circle of the Penumbra or partial Shade involving the Space of 12 Mill.m of Square Miles; to the inhabitants of which, part of the Sun is Eclipsed more or less, as they lie nearer to or further from the Shadow of total Darkness. Without the Circle* F E G *towards* A C B *the Inhabitants see the Sun free from any Eclipse*.

N B. *The Shadow is really terminated at the Surface, & its continuation to* E *is only to represent to the Eye, its length or distance to which the Shadow would otherwise reach*.

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| | October | | | |
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SN *The Perpendicular to the way of* ☽ *passing thro the Center of the Sun upon which the Distance from the Center of the Sun is to be sett of according to the direction of the Table North or South*.....

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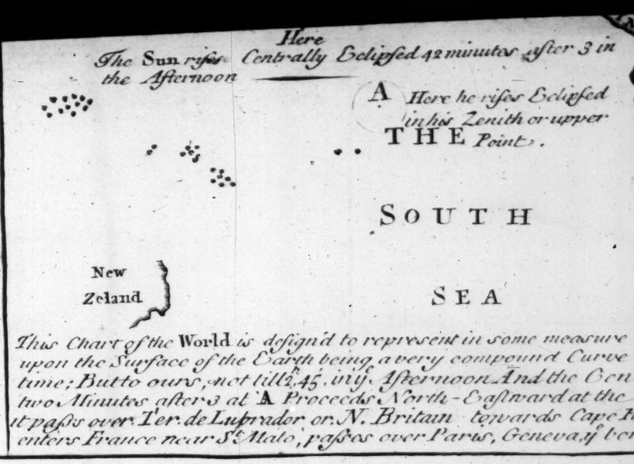


*This Chart of the* World *is design'd to represent in some measure upon the Surface of the Earth being a very compound Curve time; But to ours, not till 2.45. in*[illegible] *Afternoon. And the Central Shadow enters upon the Earth about 6 in the Morning two Minutes after 3 at* A *Proceeds North-Eastward at the rate of 2000 Miles an hour over California, Mississippi River it passes over Ter. de Labrador or N. Britain towards Cape Farewell, then changing its direction to South-East it passes the North enters France near St. Malo, passes over Paris, Geneva, borders of Switzerland, the Alps, by Palanza & Bresoia, ends at Mantua, where the Line of the Center of total Darkness, upon a Mercators Projection and properly not in a Plane. The Sun rises Eclipsed at* (A) *above the Central Shadow enters upon the Earth about 6 in the Morning at the rate of 2000 Miles an hour over California, Mississippi River*

# *A compendious* VIEW *of the* NATURE *and* KIND *of* ECLIPSES, *particularly that of the* SUN *and* EARTH, *that will happen the* 11*th of* May *in the Afternoon*, 1724.

*An Eclipse.* AN Eclipse is the Loss of Light really, or in Appearance, in any of the heavenly Bodies, caused by the Interposition of one of the Planets, and is either Solar, Stellar, or Planetary.

*Solar Eclipse.* A Solar is a Loss of Light in the Sun, in Appearance only, occasioned by the Passage between us and him; either of the Moon, as on the 11th of *May* this Year, or of the inferior Planets *Mercury* and *Venus*: These last are usually called *Transits*; one of *Mercury*, appearing like a black Spot passing over the Sun, was seen last *October*; and another of *Venus* will be visible, if the Weather be clear, the 26th of *May* 1761, beginning at 2 in the Morning, and ending about 10, lasting near 8 Hours. To this the great Astronomer of our Age, has, upon very good and intelligible Foundations, referred our Hopes for determining the famous Problem of the Sun's Parallax, upon which depends the Knowledge of the precise Magnitudes and Distances of the celestial Bodies. But an Astronomer of lesser Note thinks the Transit of *Mercury*, which will happen in *April* 1753, beginning a little before 4 in the Morning, and ending a little after 10, will likewise do the same, to the abundant Satisfaction of the Curious.

*Stellar.* Stellar Eclipses are also apparent Losses of Light in any of the fixed Stars, occasioned by the Appulse of the Moon, or any other Planet; these are called *Occultations*, being only the hiding of the Star from our Sight, by the Planets coming between them and us. These made by the Moon, bid fairest for the finding the Longitude without a Reckoning, practicable at Sea. When the numerous and large Vacancies of the *British* Catalogue of fixed Stars, within the Limits of the Zodiac, are filled up, and good Numbers of the Moon's Motions are published; both which we expect from a Person of known Abilities. The near Applications of any other Planet to the fixed Stars, tho' without an Occultation, will serve to determine their Places with great Exactness, and correct the defective stating of others: By this Means the Place of the great Comet of 1680, in its first Appearance, before it had a Tail visible to the naked Eye, was determined.

*Planetary.* Planetary Eclipses are sometimes real, and sometimes apparent only; of the latter Sort are the Occultations of a Satellite of *Jupiter*, when the Earth is at (E) in Figure 5, and the Satellite at (A); of the former are the Eclipses of the Satellites entring into the Shadow of *Jupiter* at (C); the Eclipses of the Moon or Earth. The Eclipses of the first Satellite of *Jupiter*, 13 happening every 23 Days, afford the best Means of determining the Longitude of Places at Land, and verifying the Charts of the Coast of

*The Eclipse of Jupiter by the Satellites.* the Ocean, until which, the Longitude at Sea, if found, would be of little Service. *Jupiter* not only projects a Shadow eclipsing his Satellites at certain Times, but they also cast Shadows upon his Disk, when they happen to be between him and the Sun, as at (G) the 4th does. These Shadows appear like Spots easily distinguished from any permanent Spots on *Jupiter*; for they always appear in that Place upon *Jupiter*, where some Satellite seen from the Sun would appear. They also move from the Eastern to the Western Limb of *Jupiter*, with a Motion equal to that of the Satellites to which they belong, the Satellites themselves soon after following them. If they happen before the Opposition of *Jupiter* to the Sun, or having already passed before, if *Jupiter* has been in Opposition to the Sun, sometimes several Spots has been seen at once, moving after this Manner, having the Satellites to which they belong, preceeding or following them.

*Of the Moon.* The Eclipses of the Moon is caused by her passing thro' the Shadow projected by the Earth, at a full Moon, as an Eclipse of the Earth is produced by the Moon's Shadow falling upon some Part of the enlighten'd Hemisphere of the Earth, I shall only observe, that Lunar and Solar, or more properly, Terrestrial Eclipses, revolve periodically; and that the Length of this Period is about 18 Years 11 Days, or 223 Months: So that after that Time is elapsed, the same Eclipses come over again. So the present Eclipse of the Sun or Earth, is the Return of that famous one of the 1st of *May* 1706, which was total at *Barcelona*, and happened at the very Time of raising the Siege of that Place, by the *French*, but was only 10 Digits and a half at *London*. Nor have more than one total Eclipse of the Sun been seen at *London* since the 20th of *March* 1140, tho' 7 or 8 that pass over the Parallel of *London*, are total with Continuance.

*Eclipses of the Earth and Sun.* The Figure, or Eclipse of the Earth, Figure 2, is designed to represent the general Nature of an Eclipse of the Sun and Earth, which always accompany each other. The Sun constantly enlightens about half the Earth (A C B), and Moon (D), obverted to him, and at the same Time occasions the Shadow cast by the Moon, always opposite to the Sun, but towards the Earth at a new Moon or full Earth. If this Shadow at any new Moon falls upon the Earth, as it does in that for the Month of *May*, this Year, it causes a total Darkness in that Part of the Earth which a little before was enlighten'd by the Sun.

*The Figure of the Shadow of total Darkness.* The Figure of the Shadow is circular upon the Earth, if the Axis (D E) of the Shade fall perpendicularly upon the Surface of the Earth, as it does in this Figure; but oval, if it fall obliquely; as it does in Dr. *Halley*'s Scheme, the Convexity of the Earth's Surface, for so a small Compass as the Shadow falls upon, being inconsiderable.

*The Diameter.* The Diameter of this Space, when circular and greatest, is 180 Miles, and the Area 25000, so that to all the Inhabitants within such a Compass of Ground, the Sun appears in total Darkness at the same Moment of Time.

*Length of the Shadow* The Length of the Shadow varies, and when shortest, is no less than 23400 Miles; at the present Eclipse it is above 24200.

*Velocity of the Shadow* The Swiftness the Center of the Shadow moves with over the Disk of the Earth, is above four times greater than that of a Cannon Ball, continuing in the same Degree of Velocity as it leaves the Muzzle of the Cannon.

*The Line.* The Line it describes upon the Surface of the Earth, is a very compound Curve, but its Way projected upon the Earth's Disk is rectilineal.

*The Duration.* The Duration of total Darkness in any Place, depends upon its Nearness to the Track of the Shade, it being longest in those Places over which the Center of the Shadow passes, and where it seldom exceeds 5 Minutes. The Sun rises eclipsed totally at the Place where any Part of the Shadow first touches the Earth towards the West; and centrally where the Center of the Shadow soon after does the same, which happens to be on the 11th of *May* in the *South-Sea*, or *Pacific Ocean*, about 130 Degrees West of *London*, and in the Latitude of 13° North. The Sun sets totally eclipsed at the Place where the Shadow leaves the Eastern Parts of the Earth, and centrally where the Center does the same, which happens near *Mantua* in *Italy*.

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*The general Eclipse of the Earth, and its Phænomena.* When the Sun first appears to
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The Beginning, Duration an
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Thus the general Eclipse begins a
Eclipse at *Venice*, no sooner than
The general Eclipse will last
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arises from the different Reckon
West of *London*. Thus at *Boston*
after 11 in the Morning, and
before the general Eclipse will

## *The USE of the GEN the Eclipse of the*

*To find whether the Eclipse of the*

*The Eclipse of the Sun at particular Places.* SET one Foot of a Pair of Co
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Semidiameter of the *Penumbra*, th
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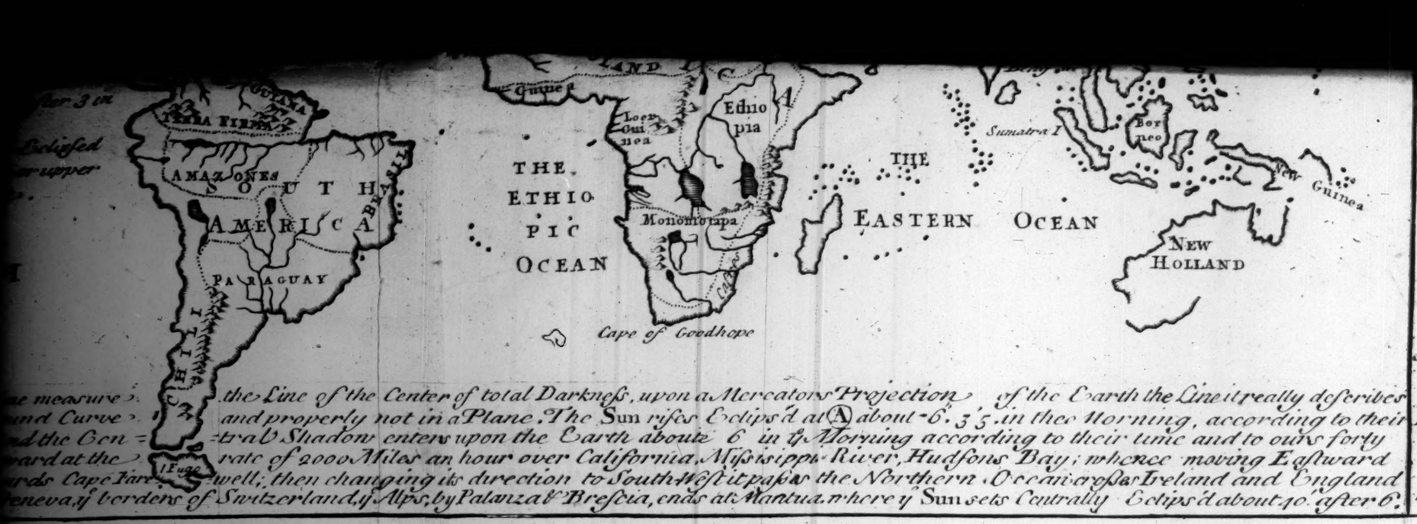
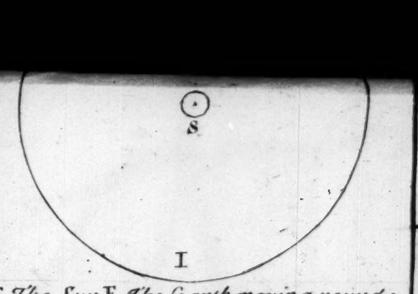
begun at 4 a Clock in the Afterno
to four Digits about 6.

N. B. The Distance between th
Moon's Way, we call the Interval

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| | | | | | |
|---|---|---|---|---|---|
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| d | | | | | |
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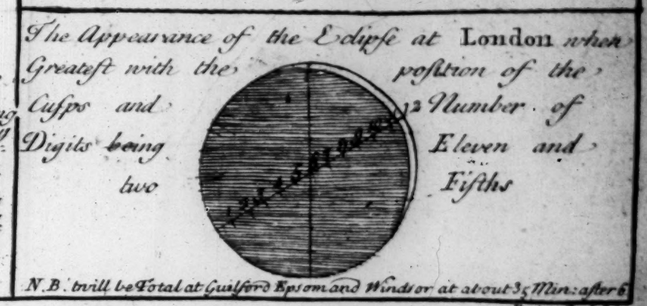


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This partial Eclipse is greater the nearer the Inhabitants are to the Circle of total Darkness, (M. N. L.) and less the nearer they live to the Circle A. C. B. in Space beyond which, the Sun appears without any Eclipse, tho' at the same Time, it is eclipsed total at (M. N. L.) just half at (H. I. K.)

*The general Scheme of the Eclipse of the Earth, May the 11th in the Afternoon, 1724.*

One half of the Earth's Surface is always enlightned by the Sun, as has been observed, the Circle bounding the Light and Shade, is called the Circle of *Illumination*; the Plain of this Circle is called the *Disk* of the Earth, and Figure I. represents its Northern half, as seen at the Distance of the Moon, in a right Line connecting the Center of the Sun and Earth, having the universal Meridian several Hour Circles, Parallels of Latitude for *London* and *Venice*, and Line of the Moon's Way, projected upon it, by Lines drawn from an Eye placed at the Sun's Center.

*The general Eclipse of the Earth, and its Phænomena.*

When the Sun first appears to be eclipsed to an Inhabitant of our Earth, to a Spectator or Inhabitant of the Moon, (if there be any such,) the Earth will begin to be eclipsed, and, soon after, the dark Shadow of the Moon, surrounded with a fainter *Penumbra*, will pass over the Surface of the Earth, along the Line of the Moon's Way, (B. D.) 'till it leaves the Earth at the Point D.

The Beginning, Duration and Ending of the general Eclipse, differ very much from the Beginning, Duration and Ending of the Sun's Eclipse, in any particular Time. Thus the general Eclipse begins at 44 Minutes after 2 in the Afternoon; the particular Eclipse at *Venice*, no sooner than 38 Minutes after 6.

The general Eclipse will last 4 Hours 36 Minutes; the particular, where it is total, as at *Bristol*, 1 Hour 48 Minutes. There is, indeed, another Difference, but that arises from the different Reckoning of the Place according as it is to the East or West of *London*. Thus at *Boston* in *New-England*, the Eclipse will begin at 38 Minutes after 11 in the Morning, and end 13 Minutes after 2 in the Afternoon, which is before the general Eclipse will be so much as begun, according to our Reckoning.

## *The USE of the GENERAL SCHEME, as it relates to the Eclipse of the Sun, the 11th of* May *this Year.*

### PROBLEM I.

*To find whether the Eclipse of the Sun be begun in any given Place, at any given Time.*

*The Eclipse of the Sun at particular Places.*

SET one Foot of a Pair of Compasses on the Time given, in the Parallel of the Place, open the Compasses 'till the other Foot touch the same Time in the Line of the Moon's Way Place; if this Distance, applied to the Scale, be greater than the Semidiameter of the *Penumbra*, the Eclipse is not begun at that Place; if equal 'tis Begining, but if less, 'tis already begun. Thus at *London* you'll find the Eclipse is not begun at 4 a Clock in the Afternoon; begins at 39 Minutes after 5, and is advanced to four Digits about 6.

N. B. The Distance between the same Hour and Minute in any Parallel, and in the Moon's Way, we call the Interval.

### PROBLEM II.

*To find the Number of Digits eclipsed at any Time after the Eclipse is begun.*

THE difference between the Interval for that Time, and Semidiameter of the Penumbra, applied to the Semidiameter of the Sun, divided into 12 equal Parts, shews the Number of Digits eclipsed. Or upon the Time given in the Parallel of the Place, make a Circle with the Sun's Semidiameter; another Circle described with the Moon's Semidiameter, upon the the same Time in the Line of the Moon's Way, will intersect the former; and the Part of the Circle of the Sun cut off, represents the Degree or Quantity of the Eclipse; thus at 6 a Clock the Sun will be eclipsed, as in the SCHEME.

### PROBLEM III.

*To find the Time of greatest Darkness, or Middle of the Eclipse.*

THE Place in the Moon's Way, where the Interval is least, shews the Time required.

### PROBLEM IV.

*To know whether the Eclipse, in a given Place, will be central total, without, or with, Continuance.*

THIS depends upon the Magnitude of the apparent Diameter of the two Luminaries compared together with the Interval. Thus, if the Interval at the Middle of the Eclipse be nothing, the Eclipse will be central, and if the Sun's apparent Diameter, exceed that of the Moon, it will be annular; if the Interval be nothing, and the apparent Semidiameters be equal, it will be total without Continuance, as it will be also, if the Interval be equal to the Excess of the Moon's Semidiameter. But if the Interval be less than that Excess, the Eclipse will be total with Continuance.

### PROBLEM V.

*To find when the Eclipse ends at a given Place.*

ONE Extremity of the Length of the Semidiamiter of the Penumbra carried along the Line of the Moon's Way, after the Middle of the Eclipse, 'till the other Extremity touches the same Hour and Minute, in the Parallel of the Place, either of the Extremities then shews the Time of ending required.

### PROBLEM VI.

*To find the Longitude or Difference of the Meridian of a Place, the Latitudes and Time of any particular Phasis of the Eclipse being given.*

THE Interval proper to that Phasis or Appearance of the Eclipse, applied to the Time given in the Parallel of the Place, will cut the Line of the Moon's Way in the Time, according to the Reckoning of the Place, to which the Scheme is fitted. The Difference of these Times turned into Degrees and Minutes, allowing one Degree of Longitude for every 4 Minutes, and so proportionally, gives the Difference of Longitude. Thus if the Phasis be the Beginning or Ending of the Eclipse, the Semidiameter of the Penumbra is the Interval to be applied; if two or more Digits be eclipsed, the Semidiameter of the Penumbra lessen'd by so many 12ths of the Sun's Diameter becomes the Interval.